

REMARKS

The Applicants have studied the Office Action dated August 20, 2004 and have made amendments to the claims to distinctly claim and particularly point out the subject matter which the Applicants regard as the invention. No new matter has been added. It is submitted that the application, as amended, is in condition for allowance. By virtue of this amendment, claims 1-30 are pending. Reconsideration and allowance of the pending claims in view of the above amendments and the following remarks is respectfully requested.

In the Office Action, the Examiner:

(1-2) objected to the drawings due to reference sign(s) not mentioned in the description; and

(3-4) rejected claims 1-30 under 35 U.S.C. §102(e) as being anticipated by Lewis et al (U.S. Pub No. 2002/0083037).

Amendment to the Specification – Related Applications

The Applicants have amended the paragraph of page 1 to supply application serial numbers for the related applications specified in that paragraph. No new matter was added.

Amendment to the Specification –Description of the Preferred Embodiments

The Applicants have amended paragraphs on pages 3 and 15 of the specification in order to properly refer to reference signs in the specification. Applicants submit that the descriptions added by these amendments are shown in the originally filed drawings they describe and in the surrounding text of the original specification. The amendment to the paragraph beginning on page 15, line 4, that describes FIG. 2B, contains information similar to the description of FIG. 2A at page 14, lines 12-15. The amendment of the paragraph beginning on page 15, line 26, that describes FIG. 3, contains similar information earlier in that paragraph, at page 15, line 26 to page 16, line 2. The amendment of the paragraph beginning on page 3, line 22, that describes FIG. 4, contains information similar to the description of FIG. 2A at page 14, lines 12-

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15. The amendment of the paragraph beginning on page 35, line 20, that describes FIG. 6B, describes information contained in FIG. 6B as is clear from the original text of the paragraph and contents of FIG. 6B. The description of FIG. 7B has been amended to include a discussion of call number 734. The amendment of the paragraph beginning at page 37, line 14 is clear from the content of FIG. 7B. No new matter was added by these amendments.

Amendment to the Claims

The Applicants have amended the independent and dependent claims to more clearly describe the claimed invention. Support for these amendments is found in the specification at, for example, page 36, lines 1-28 and page 31, line 26 to page 34, line 18. No new matter has been added by these amendments.

(1-2) Drawings

As noted above, the Examiner objected to the drawings because specified reference signs were not noted in the description. The Applicants have amended the specification to include discussion of the reference signs of FIGs. 2B, 3, 4, and 6B that were indicated by the Examiner. With regards to FIG. 7B, Applicants respectfully point out that FIG. 7B is referenced in the specification at page 35, lines 26 and 27, with a full description following from page 35, line 26 through page 37, line 17. Applicants have amended this description to discuss reference number 734. Applicants believe that drawing corrections are not required to address this objection. Applicants further respectfully assert that this objection has been overcome and should be withdrawn.

(3-4) Rejection Under 35 USC § 102(e) Lewis

As noted above, the Examiner rejected claims 1-30 under 35 U.S.C. §102(e) as being anticipated by Lewis et al (U.S. Pub No. 2002/0083037) (Hereinafter "Lewis"). The Examiner cites 35 U.S.C. § 102(e) and a proper rejection requires that a single reference teach (i.e., identically describe) each and every element of the rejected

claims as being anticipated by Lewis.¹ Applicants have amended the claims to more clearly defined the claimed subject matter and assert that the Examiner's rejections have been overcome and should be withdrawn.

Preferred Embodiments of the present invention provide an improved apparatus, computer-readable medium and method for providing writable file system snapshots that include empty inodes and/or implied reference addresses referred to as "ditto addresses." These writable snapshots substitute implied logical references for disk data blocks in order to efficiently store snapshot information while minimizing data copying. The implied logical references are indicated by the use of "ditto" addresses in inodes of the snapshot dataset. The use of implied logical references in the claimed invention overcomes problems with the prior art in general, and Lewis in particular, where only physical references to data blocks that are contained in more recent snapshot or in the original file system are discussed and used. Physical references, unlike implied logical references, are limited to specific hardware constraints such as disk size. The use of implied logical references by the claimed invention permits the re-mapping of storage locations to newly added disk space. The implied logical references that include ditto addresses of the present invention further obviate the requirement to store the physical disk address of each data block in the inodes of all of the system snapshots.

Further, the use of implied logical references obviates a need to track data block usage for the numerous snapshots and the original file system. The architecture of the present invention renders the tracking of such disk data block usage, which is the focus of the Lewis reference, completely unnecessary. The operation of the present invention creates snapshots by creating a sparse, i.e., initially empty, inode file that contains all empty inodes. Modifying metadata, i.e., data within inodes themselves, within a

¹ See MPEP §2131 (Emphasis Added) "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim."

snapshot in the processing of the present invention involves copying the modified metadata into the sparse inode file of the snapshot. Since modifying metadata does not involve changing the data stored in the data block, the operation of the present invention refers to the still current data block by using a logical implied reference, or "ditto" address.

The Lewis reference, however, is directed to capturing snapshots of active file systems and does not even mention or suggest modifying a snapshot. The teaching of Lewis is limited to only capturing new snapshots. The teachings of the Lewis reference focus on maintaining maps of disk data blocks that are used by the active file system and the various snapshots. The teachings of the Lewis reference maintain and update maps of data blocks that are used by the active file systems and snapshots. These maps facilitate identification of free data blocks in which new data can be stored. Applicants respectfully assert that a teaching of maintaining and updating tables or maps of data block usage is not a teaching of the claimed aspects of the present invention, including maintaining writeable snapshots with empty inodes, implied logical references, and the recited processing associated with those elements.

The elements in the amended independent claims 1, 6, 9, 14, 17, 22, 25 and 28 that relate to, for example, empty inodes, implied references and modifying empty inodes and referenced data blocks within a specified snapshot, are not taught or disclosed by Lewis. Accordingly, the present invention distinguishes over Lewis for at least this reason. The Applicants respectfully submit that the Examiner's rejection under 35 U.S.C. § 102(e) has been overcome.

The Applicants have amended claims 1, 9 and 17 in order to more particularly describe the operation of modifying metadata within a snapshot that contains empty inodes. This operation, as described by amended independent claim 1, recites:

accessing a specified file system snapshot in a plurality of file system snapshots, wherein the specified file system snapshot comprises at least one empty inode, wherein an empty inode indicates that an

metadata corresponding to the empty inode is contained in one of a more recent snapshot, and a source file system;

determining if an inode to be modified is an empty inode;

copying, in response to determining the inode to be modified is an empty inode, metadata corresponding to the inode to be modified into the empty inode;

writing the metadata into a next oldest file system snapshot; and

modifying the metadata copied into the empty inode.

Applicants respectfully assert that the Lewis reference does not teach “wherein the specified file system snapshot comprises at least one empty inode, wherein an empty inode indicates that metadata corresponding to the empty inode is contained in one of a more recent snapshot, and a source file system” as is recited for claims 1, 9 and 17. The system of Lewis does not teach creating empty inodes. The Applicants assert that the Lewis reference is silent on the processing performed to modify metadata.² The Lewis reference discusses the use of inodes to access data blocks, but no modification of metadata within a snapshot is discussed. The Lewis reference further does not describe a method to update metadata within a snapshot, as is claimed by amended independent claims 1, 9 and 17. Specifically, Lewis does not teach or describe the elements claimed by amended independent claims 1, 9, and 17, as is recited, for example, amended independent claim 1, which recites:

copying, in response to determining the inode to be modified is an empty inode, metadata corresponding to the inode to be modified into the empty inode;

writing the metadata into a next oldest file system snapshot; and
modifying the metadata copied into the empty inode.

The Applicants have amended claims 6, 14, and 22 in order to more particularly

² If, however, the Examiner’s statements are based on facts within the personal knowledge of the Examiner, the Applicants respectfully request that the Examiner support these statements by filing an affidavit as is allowed under MPEP § 707, citing 37 C.F.R. 1.104(d)(2).

describe the operation of modifying data blocks within a snapshot that are indicated by ditto addresses. This operation, as described, for example, by amended independent claim 6, recites:

accessing a specified file system snapshot in a plurality of file system snapshots, wherein the specified file system snapshot comprises at least one inode comprising at least one ditto address, wherein the at least one ditto address refers to a data block that has a disk address in an inode associated with one of a more recent snapshot and a source file system;

determining if a data block to be modified is referenced by a ditto address in an inode of the specified file system snapshot;

copying, in response to determining the data block to be modified is referenced by a ditto address in an inode of the specified file system snapshot, the data block to be modified into the specified snapshot;

copying the data block to be modified into a next oldest file system snapshot; and

modifying the data block copied into the specified snapshot.

Applicants respectfully assert that the Lewis reference does not teach a “at least one ditto address, wherein the at least one ditto address refers to a data block that has a disk address in an inode associated with one of a more recent snapshot and a source file system” as is recited for amended independent claims 6, 14, and 22. The Lewis reference teaches inodes with references to data blocks, but the inodes of the Lewis reference all contain actual references to data blocks, not the “ditto addresses” as they are defined in claims 6, 14, and 22.

Further, in the context of the independent claims, the present invention stores “ditto” values as disk address values in the inodes of the snapshot dataset, and not the physical address of the physical data blocks themselves. As defined by the claim language, a ditto address stored in an inode of the snapshot dataset indicates that the disk address stored in that inode refers to a data block that has a disk address in an inode associated with one of a more recent snapshot and a source file system. A “Ditto” address indicates that a “logical address” is to be determined. Determination of the logical address is detailed in the specification, as is described above in regards to FIGs. 7A and 7B and associated descriptions in the specification at pages 20 through

27. This aspect of the presently claimed invention advantageously simplifies tracking of data block usage, relocation and other actions, such as deleting and modifying, thereby obviating the need to track data block usage as is the focus of the Lewis reference.

Further, amended independent claims 6, 14, and 22 are directed to modifying a file system snapshot by "accessing a specified file system snapshot" and "modifying the data block copied into the specified snapshot." As discussed above, the Lewis reference does not discuss or describe modifying data within a snapshot. Therefore, the Applicants respectfully assert that the Lewis reference does not teach the elements of amended independent claims 6, 14, and 22.

With regards to claims 25 and 28, the Applicants have amended these independent claims to more specifically recite that their file system snapshots comprise:

at least one of an empty inode and an inode comprising at least one ditto address,

wherein an empty inode indicates that an metadata corresponding to the empty inode is contained in one of a more recent snapshot, and a source file system, and

wherein a ditto address refers to a data block that has a disk address in an inode associated with one of the more recent snapshot, and a source file system;

As discussed above, the Lewis reference only discusses inodes that include explicit disk address pointers to data blocks. However, the Lewis reference does not teach or describe snapshots that contain "empty inodes," or inodes comprising a "ditto address" as is recited for amended independent claims 25 and 28.

Additionally, Applicants note that dependent claims 2-5, 7, 8, 10-13, 15, 16, 18-21, 23, 24, 26, 27, 29 and 30 depend from amended independent claims 1, 6, 9, 14, 17, 22, 25 and 28, respectively. As discussed above, independent claims 1, 6, 9, 14, 17, 22, 25 and 28 were amended to more clearly distinguish over the cited prior art. Since dependent claims include all of the limitations of the independent claims from which they depend, Applicants further assert that amended dependent claims 2-5, 7, 8, 10-13,

15, 16, 18-21, 23, 24, 26, 27, 29 and 30 also distinguish over the cited prior art as well. Therefore, Applicants respectfully assert that the Examiner's rejection under 35 U.S.C. §102(e) over Lewis should be withdrawn.

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CONCLUSION

The remaining cited references have been reviewed and are not believed to effect the patentability of the claims as amended.

In this Response, Applicants have amended certain claims. In light of the Office Action, Applicants believe these amendments serve a useful clarification purpose, and are desirable for clarification purposes, independent of patentability. Accordingly, Applicants respectfully submit that the claim amendments do not limit the range of any permissible equivalents.

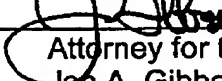
Applicants acknowledge the continuing duty of candor and good faith to disclosure of information known to be material to the examination of this application. In accordance with 37 CFR § 1.56, all such information is dutifully made of record. The foreseeable equivalents of any territory surrendered by amendment is limited to the territory taught by the information of record. No other territory afforded by the doctrine of equivalents is knowingly surrendered and everything else is unforeseeable at the time of this amendment by the Applicants and their attorneys.

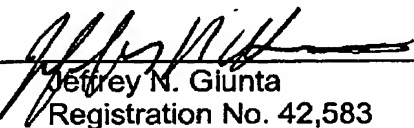
Applicants respectfully submit that all of the grounds for rejection stated in the Examiner's Office Action have been overcome, and that all claims in the application are allowable. No new matter has been added. It is believed that the application is now in condition for allowance, which allowance is respectfully requested.

PLEASE CALL the undersigned if that would expedite the prosecution of this application.

Respectfully Submitted,

Date: November 22, 2004

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